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ANNOSUS ROOT ROT

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Annosus root rot caused by Heterobasidion annosum (Fr.) Bref. (=Fomes annosus (Fr.) Karst.) is one of the most destructive diseases affecting conifers in the north temperate regions of the world (11). Nearly 150 species, including several angiosperms, have been reported as hosts for the fungus (19, 21) with major hosts belonging to the genera Abies, Juniperus, Larix, Picea, Pinus, Pseudotsuga, and Tsuga (11). Annosus root rot occurs in natural stands and plantations, but the disease is usually most serious in thinned plantations (16, 18).

SIGNIFICANCE. Annosus root rot has become increasingly serious in pine plantations in the U. S. over the past 25 years (20). Powers and Verrall (18) found that 59 and 44%, of thinned loblolly and slash pine plantations, respectively, were infected with H. annosum. While overall losses were considered small with less than 3% of the trees killed or infected, infection in individual plantations ranged up to 30%. These figures are probably conservative since they are based on only the "most certain symptoms and signs" (18), neither of which are always found on infected trees (12). Driver and Dell (3) estimated mortality losses of 20% of the wood volume within 5 years following thinning in one slash pine plantation. Recent data indicate that additional losses may be incurred due to reduced growth of infected trees (5). The full impact of this disease in Florida is not well defined. However, a recent survey of 14 north central counties (Barnard, 1978, unpublished) revealed 8 of 64 slash pine plantations, thinned within the past 10 years, in which _H. annosum had been reported. An additional 23 plantations were reported to be exhibiting symptoms typical of this disease.

BIOLOGY OF THE PATHOGEN. Long range dispersal of H. annosum is effected by means of airborne basidiospores. These spores are produced in fruiting bodies (conks) which may be found on infected roots and stumps or at the bases of infected trees beneath the duff or needle litter. Conks are leathery in texture with grayish brown to dark-brown upper surfaces and creamy white, minutely poroid lower surfaces which sometimes darken with age. Conks vary from smooth to wrinkled or deeply convoluted and often grow intermingled with needles, etc., from the forest floor. Although innately perennial, conks of H. annosum are often difficult to find because of their variable production and sometimes rapid decomposition. Conks vary in size from small "pustules" or "buttons" to brackets up to several inches across (8, 12, 17). Basidiospore production is highly seasonal. In the south, spore production is abundant from fall to spring but drops to near zero with the onset of higher summer temperatures (20).

Basidiospores germinate on the surface of fresh-cut stumps of susceptible host species. The stumps are colonized by the fungus which grows into the stumps' roots and proceeds via root contacts or grafts into root systems of adjacent trees. The fungus spreads locally within a given stand at approximately 1-2 m/year, resulting in typical root disease "infection centers" with expanding radii (8, 11, 12). While this process accounts for the majority of infections and the disease's strong relationship to thinned plantations, there is evidence that infections also arise from direct penetration of roots by germinating basidiospores or conidia which are the asexual spores of the Oedocephalum imperfect stage of _H. annosum (10, 13).

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H. annosum is influenced by numerous edaphic and biotic factors. Greatest pathogen and disease development occurs on sites with deep, well-drained, sandy or sandy-loam soils with low organic matter and relatively high pH values. Conversely, sites characterized by heavier soils, lower pH values, more organic matter, and poor internal drainage or high water tables tend to inhibit, not necessarily exclude, development of the fungus (6, 9, 14, 15). The activity of H. annosum is also suppressed by competitive microorganisms such as Peniophora gigantea (Fr.) Massee and Trichoderma spp. (2, 4).

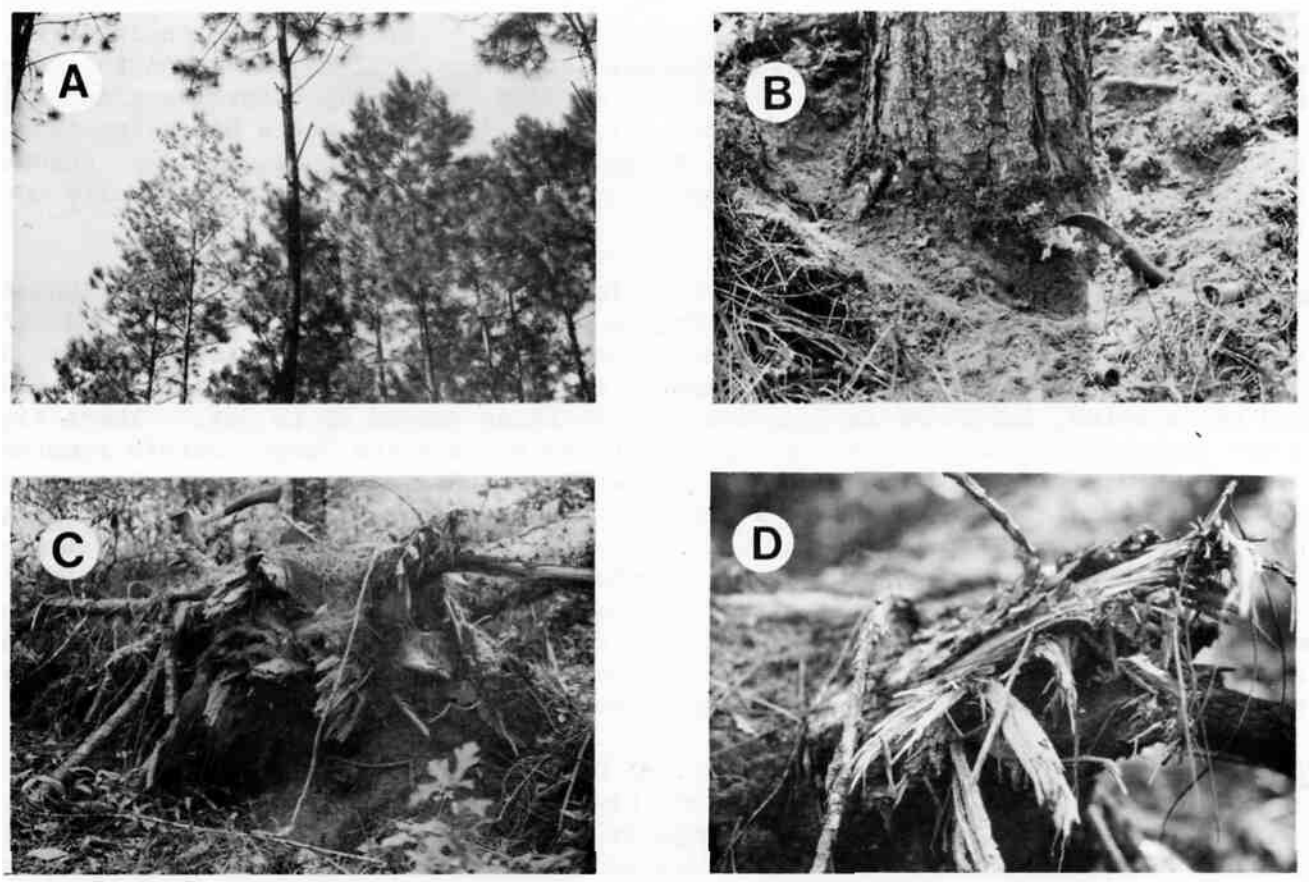

Fig. 1. Evidence of Heterobasidion annosum infection in a slash pine plantation in north central Florida: A) Thin crowned tree (left rear); B) Conk at base of infected tree (duff layer removed): note white undersurface beneath blade of knife; C) Windthrown tree with decayed roots exposed; D) Shredded appearance of decayed root.

SYMPTOMS. Infected stands may be characterized by dead trees; trees with thin, discolored, or otherwise unthrifty crowns; and/or leaning or completely uprooted, wind-thrown trees (live or dead) due to fungus-decayed root systems. Infected roots display varying patterns of discoloration or staining, resin soaking, and decay, depending on host and stage of disease development. Advanced decay is typified by small elongated white pockets, sometimes with attendant black spots or flecks, that eventually coalesce and reduce the roots to a shredded or stringy condition (1, 12, 17).

Infection centers are often confused with bark beetle (esp. Dendroctonus and _Ips_ spp.) spot kills due to similar group killing patterns. Often, bark beetles preferentially attack trees weakened by H. annosum, and superficial inspection of damaged stands results in incorrectly attributing the problem to the insects because of their characteristic, readily visible pitch tubes. Annosus root rot centers can usually be distinguished from bark beetle kills by their progressive killing pattern which leaves trees in various stages of decline as opposed to the "one shot" kill pattern of beetles with infested

trees all in one stage of deterioration. The presence of H. annosum conks is useful too, but in their absence laboratory isolation of the fungus is required for confirmation (12, 17).

CONTROL. Effective measures, including chemical stump treatment, biological control, and preventive silviculture have been developed to minimize losses to H. annosum (7, 8, 14). These are adapted and outlined below.

I. Disease-free Stands

A. "High Hazard" Sites: deep, well-drained sands or sandy loam soils, low in clay and organic matter.

1. Thin in summer months, May through September, if possible. Spores of H. annosum are less abundant in summer and are killed by the heat which builds up on stump surfaces during this season in Florida. Exceptions might include prolonged periods of rain and areas of bark beetle buildup.

2. Apply granular, technical grade borax to fresh-cut stump surfaces when thinning, if thinning is performed in season other than summer (May through September).

3. Encourage silvicultural prescribed burns. Evidence indicates a side effect of this practice may be a reduction in annosus root rot infections.

4. Minimize the number of thinnings per crop rotation.

5. Consider longleaf pine as a regeneration option on sites where this species is silviculturally adapted. Limited evidence suggests this species is the least susceptible of the major southern pines.

B. "Low Hazard" Sites: poor internal drainage and high seasonal water tables, shallow soils with abundant clay and organic matter, e.g.,"Flatwoods".

1. Preventive measures are generally not required.

II. Diseased Stands

A. Salvage timber as practicable in badly diseased stands to minimize economic losses. Note age of infection center (time since thinning) as mortality and windthrow maximize after 4-8 years and tend to stabilize thereafter (12).

B. When thinning diseased stands apply P. gigantea to stumps instead of borax. Use of borax in stands already infected with H. annosum can make matters worse by inhibiting the action of competitive microflora. (P. gigantea available from BioBasic, P. 0. Box 5668, Raleigh, NC 27707.)

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